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Verification of Efficiency Vermont's Energy Efficiency Portfolio for Annual Savings Claim and the ISO-NE Forward Capacity Market

Program Year 2020

Final Report

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Final Report

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1   Introduction

Efficiency Vermont (EVT) bid its efficiency program portfolio into the Independent System Operator of the New England's (ISO-NE) Forward Capacity Market (FCM). To participate in the market, providers of energy efficiency resources must demonstrate that their efficiency savings are verified in compliance with the ISO-NE standards established for this purpose.[1] EVT submitted a measurement and verification (M&V) plan stating that the evaluation process in Vermont will comply with ISO-NE standards and the Vermont Department of Public Service (Department or PSD) was charged with conducting the independent evaluation required by the ISO-NE standards.

The methods available to the Department to evaluate EVT's FCM claims are defined by both the ISO-NE standards and the EVT M&V plan. These standards are designed to result in a high degree of reliability for the resources purchased through the FCM and represent a rigorous level of evaluation.

The Department contracted with West Hill Energy and Computing to provide independent verification of EVT's energy efficiency portfolio. The PSD Evaluation Team, consisting of West Hill Energy, Cx Associates, Lexicon Energy Consulting, and DNV, implemented the FCM impact evaluation, including a statistical analysis, site-specific M&V, and overall evaluation of each component of the efficiency portfolio.

This report describes the evaluation of EVT's program year 2020 (PY2020) FCM bid and the results of this verification process. It also provides the documentation to support the Annual Certification of Accuracy of Measurement and Verification Documents, as specified in Section 17.2 of the ISO Manual for Measurement and Verification of Demand Reduction Value from Demand Resources (M-MVDR, Revision 7, October 4, 2018).

The evaluation was designed to determine the appropriate realization rates (RRs) to be applied to EVT's estimated savings. The RRs given in this document were provided to EVT in May 2022 and will be used to adjust EVT savings as reported to ISO-NE from July 1, 2022, until the completion of the next evaluation cycle.

The remainder of this report is divided into six sections: program activity, methods, results, compliance with ISO-NE standards, conclusions, and references. Additional detail about the components of portfolio savings can be found in the EVT 2020 Annual Report.[2]

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[1] *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual (M-MVDR), Revision: 7, Effective Date: October 4, 2018.*
[2] *https://www.efficiencyvermont.com/Media/Default/docs/plans-reports-highlights/2020/efficiency-vermont-annual-report-2020.pdf.*

2   Program Activity

For PY2020 evaluation cycle, the PSD Evaluation Team divided EVT's portfolio into three categories, commercial and industrial (C&I), residential, and multifamily (MF). The following sections provide more details on the types of projects completed for each sector.

2.1 Commercial and Industrial (C&I) Programs

EVT's C&I programs include custom and upstream programs. All custom C&I projects were categorized as either retrofit or new construction /market opportunity (NC/MOP). EVT also offers measures such as heat pumps, circulator pumps, heat pump water heaters, condensing units, and Smartlights through their upstream initiatives. A summary of savings by C&I group is provided in Table 2-1.

TABLE 2-1: SUMMARY OF C&I PROJECTS

Group	Number of Sites	Energy Savings (kWh)	Winter Demand Savings (kW)	Summer Demand Savings (kW)
Retrofit	277	22,768,865	2,711	2,760
NC/MOP	362	9,429,422	1,061	1,307
Upstream	6,856	26,264,122	3,162	4,049
Total C&I Portfolio	7,495	58,462,409	6,934	8,117

2.1.1 Upstream Programs

Upstream initiatives are intended to promote energy efficiency by offering incentives to distributors who pass on the benefit to customers as a product discount. EVT has two major upstream initiatives that account for 22% and 37% of the entire PY2020 portfolio's winter peak and summer peak kW:

1.   Smartlight program, which covers efficient lighting

2.   Heating, ventilation, and air conditioning (HVAC) equipment upstream program.

The Smartlight Program is an upstream program implemented jointly by EVT and BED. Through this program, lighting distributors receive incentives enabling them to sell high-efficiency lighting to households and businesses in Vermont at a comparable cost to standard efficiency lighting.

EVT has been expanding upstream programs to include heat pump water heaters, cold climate heat pumps (CCHPs), high performance circulator pumps, and commercial refrigeration measures. Similar to the Smartlight Program, the incentives are provided through qualified distributors and manufacturers. In PY2020, the highest percentage of upstream measures were Smartlights followed by cold climate heat pumps (CCHPs) and commercial refrigeration measures.

2.2 Residential Sector

EVT offers residential energy efficiency upgrades and most of the program reported savings are almost entirely prescriptive. Table 2-2 provides a summary description of products offered through residential initiatives.

TABLE 2-2: DESCRIPTION OF RESIDENTIAL MEASURE GROUPS

MEASURE GROUP	DESCRIPTION
Residential Prescriptive Lighting	Lighting measures offered through the Efficiency Products Program (EPP) and Residential Upstream Initiatives
Residential Prescriptive HVAC	Room air conditioners and CCHPs offered through EPP residential new construction (RNC) programs
Other Residential Measures	Dishwashers, clothes washers, refrigerators, domestic hot water (DHW) pipe insulation, pool pumps, thermostats, thermal shell measures and electronics offered through EPP, RNC, low-income, and residential retrofit programs. DHW measures, insulation, and air sealing measures provided through EVT's HPwES, accounted for 0.3% of the residential portfolio.

The majority of the residential sector savings is from prescriptive lighting, which makes up about 64% and 57% of the residential winter and summer peak savings, respectively. Table 2-3 provides the savings summary by measure group.

TABLE 2-3: SUMMARY OF RESIDENTIAL SAVINGS

Initiative	Energy Savings (kWh)	Winter Demand Savings (kW)	Summer Demand Savings (kW)
Prescriptive Lighting	15,903,826	4,366.229	1,195.947
Prescriptive Lighting with Cooling Bonus	7,694	0.793	1.598
Prescriptive A/C	6,565,462	1,578.767	218.728
Other Residential Measures	6,667,187	913.262	590.138
Efficient Pool Pumps	560,929	0.000	336.087
Total Residential Portfolio	29,705,098	6,859.050	2,342.499

2.3 Multifamily

The MF programs for PY2020 accounted for about 1 GWh of energy savings, 200 kW of winter peak, and 80kW of summer peak reduction, which represents a small part of EVT's portfolio. Since the MF program has not been fully evaluated in past years, the PSD evaluation Team conducted a more rigorous evaluation for PY2020.

Retrofit, prescriptive, and NC projects were included in the sample. A stratified random sample of sites was selected for review and the measures were divided into three categories:

1. Lighting

2. Other prescriptive measures (hot water efficiency, refrigeration, cooking and laundry, and ventilation

3. Custom (weatherization and custom ventilation).

The total program reported savings by measure category are shown in Table 2-4.

TABLE 2-4: PROGRAM REPORTED SAVINGS BY MEASURE GROUP FOR THE MF PROGRAMS

Measure Group	Annual kWh Savings	Winter Peak kW Reduction)	Summer Peak kW Reduction	% of MF kWh[1]
Lighting	608,317	112.750	56.573	59%
Other Prescriptive	107,199	13.919	11.276	10%
Custom	313,615	69.008	12.928	30%
Total MF Savings	1,029,131	195.677	80.777	

[1] Total does not equal 100% due to rounding.

3   Methods

EVT bid its entire portfolio of energy efficiency initiatives into the FCM. The PSD Evaluation Team reviewed each component of the portfolio. The verification approach for each component was selected according to the types of measures and projects and the requirements specified in the ISO-NE M-MVDR.[3] The portfolio was divided according to the source of the coincidence factors (CFs). The evaluation categories and associated verification strategies are summarized in Table 3-1 and each of the categories is discussed in the subsequent sections.

TABLE 3-1: FCM VERIFICATION STRATEGY BY EVT MEASURE GROUP

Project Type	Sampling Approach	ISO and M&V Option
C&I		
Retrofit	Sample selected per ISO standards	Options A through D
NC/MOP		
Smartlight	Sample selected per ISO standards	Option A
Other Upstream Measures[1]	Prescriptive assumptions, no sampling necessary	Option A
Residential		
Prescriptive Lighting	Prescriptive assumptions, no sampling necessary	Option A
Prescriptive A/C		
Other Residential Measures		
Efficient Pool Pumps	Census attempt, no sampling necessary	Option C
Multifamily		
Multifamily	Sample selected per ISO standards	Options A and C

[1]Other PY2020 upstream measures include CCHPs, refrigeration, circulator pumps, heat pump water heaters and appliances.

3.1 Commercial and Industrial (C&I)

All projects were categorized as either retrofit or NC/MOP. Within each of these categories, projects were sorted into three strata based on magnitude of maximum peak demand savings. The PSD Evaluation Team selected a sample of projects and conducted site-specific M&V in accordance with the ISO-NE M-MVDR. The following section provides additional detail on the sampling approach.

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[3] *ISO New England Manual for Measurement and Verification of On-Peak Demand Resources and Seasonal Peak Demand Resources*, Revision: 7, Effective Date: October 4, 2018.

3.1.1 Sampling

As part of the PY2020 evaluation, a sample including small, medium, and large custom C&I projects was evaluated. The sample was selected using the site as the primary sampling unit. The stratified sample was developed based on the ratio estimation methodology presented in Chapter 11 of the National Renewable Energy Laboratory (NREL) Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.[4] The sample sizes were set at a level designed to exceed the minimum required to estimate savings at the 80/10 confidence/precision. Table 3-2 provides a summary of the sampling approach.

TABLE 3-2: SUMMARY OF C&I SAMPLING APPROACH

Sampling Component	Description	Comments
Population Size	249 sites	All C&I sites were included in the population. MF projects were evaluated separately.
Sample Frame	220 sites	Projects with maximum kW reduction less than 1.02 kW and 0.53 kW for the retrofit and NC/MOP projects, respectively, were removed from the sample frame. These projects accounted for 2% or less of the program reported peak savings.
Stratification	Higher value of the kW peak reduction (max kW), either winter or summer	C&I projects were divided into 2 categories of retrofit and NC/MOP. Three size strata were used within each program category. Sample sizes were calculated using an error ratio of 0.95 for the retrofit and 0.6 for the NC/MOP projects based on the error ratios from previous evaluations.
Primary Sampling Unit	Site	The unique site was the sampling unit to account for interactive effects. All measures at the site, including stipulated lighting were evaluated.
Target Sample Size[1]	62	Random selection was applied to small and medium projects (stratum 1 and 2). A census of the largest projects in the retrofit and NC/MOP categories were evaluated.

Below are the differences between the PY2015 and PY2020 sampling:

- Three size strata were selected for PY2020 instead of four strata.
- The max kW cut off for retrofit was slightly higher for PY2020 (1.02 max kW) than PY2015 (0.80 max kW).
- The evaluation team selected a considerable number of alternates for the sample to account for sites that are now out of business or will not allow site visits due to Covid-19 pandemic.

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[4] *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*, *Chapter 11.* Prepared for National Renewable Energy Laboratory. September 2011 – September 2016

- Stipulated lighting measures were included in the sample for evaluation for all strata since the PY2012 stipulating lighting study is now outdated.

- MF projects were excluded from the PY2020 custom C&I sample and evaluated separately.

The following sections provide a detailed description of the C&I portfolio evaluation methods.

3.1.2 Summary of C&I Sites

Table 3-3 shows the number of sites in each of these categories and the energy and peak savings within each stratum. As is consistent with the PY2015 sampling plan, the primary sampling variable was defined as the higher value of the winter or summer kW. This sampling variable was selected to ensure reliable results for both winter and summer peak kW reduction.

TABLE 3-3: SUMMARY OF C&I PROJECTS

Group	Number of Sites	Energy Savings (kWh)	Winter Demand Savings (kW)	Summer Demand Savings (kW)
Retrofit	277	22,768,865	2,711	2,760
NC/MOP	362	9,429,422	1,061	1,307
Total Custom C&I Portfolio	639	32,198,287	3,772	4,068

3.1.3 Covid-19 Impacts on Analysis Methods

One complication in evaluating PY2020 was the Covid-19 pandemic lockdown that started in March 2020. Some facilities went out of business, closed temporarily, or cut back their hours of operation. The approach to analyzing sampled sites was determined on a site-by-site basis, as explained in Table 3-4.

TABLE 3-4: APPROACH TO ASSESSING COVID-19 IMPACTS

COVID-19 Impact	Approach	Disposition
None	Proceed as usual	Include in sample
Temporary	Assess whether there is an effective approach to normalize use, production, *etc.*	If effective approach to address change, include in sample; otherwise, remove from sample and replace with an alternate
Permanent	Assess whether baseline use can be estimated based on post-install conditions	If baseline can be adjusted, include in sample; otherwise, remove from sample and replace with an alternate

The evaluation team selected a sample of 62 sites with 20 alternates selected on the assumption that some selected projects would not be able to be evaluated. Prior to beginning development of the analysis plans for each site, the evaluation team conducted the following analyses for each sample site:

1. Initial AMI analysis to determine facility-wide pre- and post-period usage changes

2. Internet business search to identify closures or change in operations

3. Initial customer survey to verify status of operations and Covid-19 impacts on operating hours.

For each site, the evaluation team chose the FCM-compliant method that took site-specific requirements into account. Option C whole-building analysis approach was limited to sites without a substantial change in operation and/or with sufficient data to remove periods of atypical operation. Pre-analysis plans providing details on the metering and analysis methods were provided to EVT for review and comment.

3.1.4 Smartlight Program

The Smartlight Program is an upstream program implemented jointly by EVT and BED. Through this program, lighting distributors receive incentives enabling them to sell high-efficiency lighting to households and businesses at a comparable cost to standard efficiency lighting.

The residential/commercial split reflects EVT's strategy of applying sector-specific savings assumptions to this lighting program. EVT's estimate of the percent of lighting products installed in residential locations was updated based on the information provided in distributors' spreadsheets.

The Smartlight projects accounted for 41% and 49% of the C&I portfolio winter and summer peak, respectively. The guidelines for Smartlights sampling included the following:

o A stratified random sample was selected for a phone survey to verify in-service rates (ISRs), facility types, facility hours of operation, and operational changes due to Covid-19.

o The sampling unit was the location ID. Sample location IDs were divided into five strata.

o The primary variable for establishing the size strata was the maximum of the EVT-reported winter and summer peak kW reduction. The smallest stratum, accounting for 0.1% of the population, was not included in the sample.

o Sample sizes were calculated to exceed the minimum required to estimate savings at the 80/10 confidence/precision level.

To estimate savings from the Smartlight measures, the PSD Evaluation Team conducted a phone survey between January and April 2022. Company name and address fields in the distributor spreadsheets were used to look up phone numbers on the internet. An incentive of $25 was offered to respondents who completed the survey.

Metering was conducted for two sites, where the Vermont Load Shape Analysis (VLSA)[5] study could not be applied, to determine the CFs.

3.1.5 HVAC Upstream Program

The highest percentage of upstream measures were CCHPs and circulator pumps. EVT reported sales of 654 CCHPs and 815 circulator pumps. In contrast, the HVAC upstream measures account for a small percentage (~4%) of the C&I portfolio. To verify HVAC upstream program savings, the evaluation team compared program reported savings against the Vermont Technical Reference Manual (TRM).

3.1.6 C&I Attrition

Two sites were dropped from the sample. For one stratum 3 site, EVT could not provide the data needed to verify savings. The other stratum 2 grocery was in a municipal electric territory and AMI data was not available.

3.1.7 Calculation of Realization Rates

The RR is the ratio of verified energy savings to the program's reported savings. The RR represents the percentage of program-estimated savings that is actually achieved based on the results of the evaluation M&V analysis. The RR was calculated as follows:

$$b = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i x_i}$$

Where,

   b is the realization rate (ratio estimator)

   i represents the project number

   n is the total number of verified projects in the sample

   w_i is the expansion weight for project i

   y_i is the verified savings for project i

   x_i is the program reported savings for project i

The basis for these calculations and the method for calculating variances are provided in the Uniform Methods Project.[6]

The sampling weights were adjusted for non-response and the RRs were applied to the population based on the percent of the kW peak savings in each stratum.[7]

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[5] *Vermont Load Shape Analysis. Final Report.* West Hill Energy & Computing. December 30, 2021.
[6] Un*iform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 11.* Prepared for National Renewable Energy Laboratory. September 2011 – September 2016.
[7] "Sampling: Design and Analysis." Lohr, Sharon L., Duxbury Press, 1999, pages 268-269.

3.2 Residential

EVT program-reported residential sector savings are almost entirely prescriptive and calculated using assumptions that have been reviewed by the PSD and included in the TRM. The TRM contains engineering algorithms for prescriptive savings developed from relevant studies and EVT's data on measures installed by past program participants. The approach used for each of the measure categories is described briefly in Table 3-5.

TABLE 3-5: RESIDENTIAL LOAD PROFILE SOURCES

Measure Category	Source of Coincidence Factor	Percent of Total Portfolio	
		Winter kW	Summer kW
Residential Prescriptive Lighting	NEEP Residential Lighting Study[1], NEEP C&I Load Shape Study for Cooling Bonus[2]	31%	11%
Prescriptive A/C	Residential Room Air Conditioner Coincidence (RAC) Factor study[3] Vermont Residential CCHP Study[4]	11%	2%
Other Residential Measures	Engineering estimates[5]	7%	6%
Efficient Pool Pumps	AMI data analysis for efficient pool pumps	0%	3%
Residential as % of Total Portfolio		49%	22%

[1] Northeast Residential Lighting Hours-of-Use Study. Prepared by NMR Group, Inc. and DNV GL. Somerville, MA. May 5, 2014.
[2] C&I Lighting Load Shape Project FINAL Report. Prepared for the Northeast Energy Efficiency Partnerships' Regional Evaluation, Measurement and Verification Forum by KEMA, Middletown, CT. July 19, 2011.
[3] Coincidence Factor Study Residential Room Air Conditioners. Prepared for the Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group by RLW Analytics, Middletown, CT. June 23, 2008.
[4] Evaluation of Cold Climate Heat Pumps in Vermont. Prepared for the VT PSD by the Cadmus Group Inc. November 3, 2017.
[5] While the load profiles for appliances such as dishwashers, clothes washers and refrigerators are based engineering estimates, the extensive nature of the data collection would be extremely costly to reproduce for measures that represent a small fraction of EVT's portfolio.
[6] "Impact Evaluation of Efficiency Vermont's Home Performance with ENERGYSTAR, Program Years 2014-2016", Prepared for Vermont PSD by West Hill Energy & Computing, September 10, 2018.
[7] It would be costly to develop load profiles from primary research for the measures that constitute a small percentage of overall portfolio.

PY2020 residential portfolio was mostly lighting. Verification was conducted as follows:

° Winter and summer peak CFs were taken from the 2014 NEEP residential lighting study (2014).[8]

o The ISR was based on values agreed upon from the 2018 Vermont Technical Advisory Group (TAG) Agreement, as specified in the TRM.

o Baseline wattages were based on less efficient, lumen-equivalent lamps meeting the federal standard.

The efficient case was the purchased product, *i.e.*, the Energy Star-qualified lamp.

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[8] NMR Lighting Study, 2014, page IX.

3.3 Multifamily

MF measures were evaluated through a variety of approaches, depending upon the type of project and specifics of the measure. NC measures were compared to the Vermont energy code and custom measures were evaluated using advanced metering infrastructure (AMI) data. Prescriptive measures were compared to the Vermont TRM.

The evaluated savings were calculated for each site in the sample and then aggregated as is consistent with the sampling plan. The detailed MF report can be found in Appendix E.

3.3.1 Sampling

A stratified random sample was selected. The sampling unit was the site, *i.e.*, if multiple buildings were located at a site, all buildings were treated as one site. Sites were divided into four strata. The primary variable for establishing the size strata was the EVT reported maximum of the winter and summer peak kW (max kW). Sites in the smallest stratum, accounting for 2% of the max kW, were removed from the sample frame. The sample sizes were calculated to exceed the minimum required to estimate savings at the 80/10 confidence/precision level assuming an error ratio of 0.65.

Table 3-6 shows the cumulative savings for each of the five strata. A census of projects was reviewed in the top two strata (3 and 4). These two strata account for 55% to 60% of the total program winter and summer peak reduction and the kWh savings.

TABLE 3-6: PROGRAM REPORTED SAVINGS BY SAMPLING STRATUM

Strata	Number of Sites	kWh	kWWin	kWSum	kWMax
0	101	15,574	3.834	1.555	3.834
1	51	130,056	30.837	10.949	30.837
2	9	272,004	45.608	25.266	45.608
3	4	286,943	51.196	23.703	51.196
4	3	334,721	65.818	20.114	65.818
Total	168	1,039,297	197.293	81.587	197.293

3.3.2 Verification Approach

The projects were evaluated according to the type of project, the available data, and the specifics of the measures. The approach to establishing the baseline and the FCM verification method for each measure group is shown in Table 3-7.

TABLE 3-7: C&I BASELINE APPROACH BY PROJECT TYPE AND MEASURE GROUP

Measure Group	New Construction	Prescriptive	Retrofit	FCM Method
Lighting	Vermont Energy Code[1]	Vermont TRM or federal standard[2]	Pre-existing conditions	Option A, partially measured isolation retrofit
Other Prescriptive	Vermont TRM	Vermont TRM	N/A	Section 5.3 Other Options (TRM review)
Custom	Vermont Energy Code	N/A	Pre-existing conditions	Option C, whole building

[1] Residential Building Energy Standards for 3 stories or less, Commercial Building Energy Standards for over 3 stories)
[2] The federal standard is specified in the Energy Independence and Security Act of 2007 (EISA).

4   Results

The RRs and relative precision for all components of EVT's portfolio are provided in Tables 4-1 and 4-2. FCM standards require sampling precision at the 80/10 confidence/precision level for the entire portfolio. The relative precision of the portfolio is 5.4% for winter and 5.7% for summer peak reduction at the 80% confidence level, which exceeds the FCM requirement.

TABLE 4-1: REALIZATION RATES AND SAMPLING PRECISION FOR WINTER PEAK kW REDUCTION

Project Type	EVT Program Reported Peak kW Savings	Realization Rate	PSD Verified Peak kW Winter Savings	Relative Precision
C&I Sector				
Retrofit	2,711	78.2%	2,120	7.6%
NC/MOP	1,061	89.9%	954	18.6%
Smartlight	2,873	132.5%	3,807	12.4%
Other Upstream[1]	290	100.0%	290	0.0%
Residential Sector				
Lighting Prescriptive	4,366	101.4%	4,429	13.9%
Lighting Prescriptive with Cooling Bonus	1	100.0%	1	3.0%
Prescriptive A/C	1,579	100.0%	1,579	0.0%
Other Residential Measures	913	97.9%	894	0.0%
Efficient Pool Pumps	0	100.0%	0	0.0%
Multifamily				
Multifamily	196	59.4%	116	12.0%
Total	13,989	101.4%	14,192	5.4%

[1] Other PY2020 upstream measures include CCHPs, refrigeration, circulator pumps, heat pump water heaters and appliances.

TABLE 4-2: REALIZATION RATES AND SAMPLING PRECISION FOR SUMMER PEAK kW REDUCTION

Project Type	EVT Program Reported Peak kW Savings	Realization Rate	PSD Verified Peak kW Summer Savings	Relative Precision
C&I Sector				
Retrofit	2,760	74.3%	2,050	6.8%
NC/MOP	1,307	81.3%	1,063	5.2%
Smartlight	3,938	79.4%	3,128	13.7%
Other Upstream[1]	111	100.0%	111	0.0%
Residential Sector				
Lighting Prescriptive	1,196	93.2%	1,114	14.1%
Lighting Prescriptive with Cooling Bonus	2	100.0%	2	3.0%
Prescriptive A/C	219	100.7%	220	10.4%
Other Residential Measures	590	99.5%	587	0.0%
Efficient Pool Pumps	336	14.7%	49	15.0%
Multifamily				
Multifamily	81	64.8%	52	11.0%
Portfolio Total	10,540	79.5%	8,376	5.7%

[1] Other PY2020 upstream measures include CCHPs, refrigeration, circulator pumps, heat pump water heaters and appliances.

The relative precision for the C&I custom sample was calculated from the sample. For prescriptive and upstream measures, the relative precision was estimated based on the available information, as discussed below.

- The CFs for Smartlight measures were taken from the VLSA study that provides either Vermont-specific CFs or support for continuing to use the previous NEEP lighting study. Metering was conducted for sites where the VLSA was not applicable.

- Savings for residential CCHPs were based on a previous impact evaluation of CCHPs in Vermont.[9]

For residential measures, the relative precision was determined as described below.

- For the residential pool pump measure in the efficient products program, the PSD Evaluation Team applied PY2018 results based on analyses of AMI data, as per M-MVDR option C, to verify the prescriptive assumptions from the TRM.

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[9] "Evaluation of Cold Climate Heat Pumps in Vermont." Prepared for the Vermont PSD by the Cadmus Group Inc. November 3, 2017.

- For a few other residential measures and the other upstream C&I measures, the load profiles were based on engineering assumptions. Since no sampling was conducted, there is no sampling error associated with these measures.

The relative precision in the NEEP residential lighting study was reported at the 90% confidence level and subsequently adjusted to the 80% confidence level. The relative precision for the prescriptive residential lighting from the NEEP residential lighting study was about 14% for both winter and summer peak demand reductions at the 80% confidence level.

The remainder of this section summarizes custom C&I results, C&I stipulated lighting results, and residential results.

4.1 Custom C&I Results

The distribution of PY2020 projects, along peak kW winter RRs and peak kW summer RRs, are provided below in Tables 4-3 and Table 4-4. Stratum 1 contains the smallest projects and stratum 3 the largest.

TABLE 4-3: REALIZATION RATES FOR CUSTOM C&I RETROFIT BY PROJECT SIZE

Size Stratum	Total 2020 Projects	Evaluated Projects	Winter kW Realization Rate	Summer kW Realization Rate
1	113	13	103%	90%
2	28	12	86%	80%
3	13	12	50%	52%
Total	154	37	78%	74%

TABLE 4-4: REALIZATION RATES FOR CUSTOM C&I NC/MOP FOR kW PEAK BY SIZE

Size Stratum	Total 2020 Projects	Evaluated Projects	Winter kW Realization Rate	Summer kW Realization Rate
1	163	6	62%	41%
2	34	6	114%	78%
3	11	11	84%	94%
Total	208	23	90%	81%

As can be seen in the tables above, the RRs for the C&I market sectors vary from 41% to 114%. Some of the common reasons for the difference in RRs are listed below.

- Savings were zeroed out for a total of 6 sites for the following reasons: increased usage in the post period, efficiency measures were not installed, refrigeration baseline energy

efficiency ratio (EER) was higher than efficient case EER, VFDs were operating at 100%, and insufficient support for savings.

- o Baseline assumptions were found to be incorrect, *e.g.*, a baseline adjustment was made to grocery store interior lighting to be consistent with the M-MVDR requirement to use the state energy as code baseline for equipment replacement with no pre-install metering, which reduced the baseline for the interior lighting.

- o Schedule, operating parameters, or production levels were mischaracterized, *e.g.*, PSD metered CFM and kW data from the compressors showed much lower savings than reported by EVT.

These types of adjustments are commonly found in the process of conducting an impact evaluation. RRs by project are provided in Appendix A and the project-specific reports are compiled in Appendix B.

4.1.1 Covid Impacts

A total of 60 sites in the C&I sample were reviewed. Out of the 60 sites, three of the sites had no savings for reasons unrelated to Covid-19 and Covid-related questions were not asked. Out the remaining 57 sites, 33 reported no changes due to Covid, 13 reported temporary changes, and 11 reported permanent changes. Figure 4-1 gives a summary of the Covid-19 survey results.

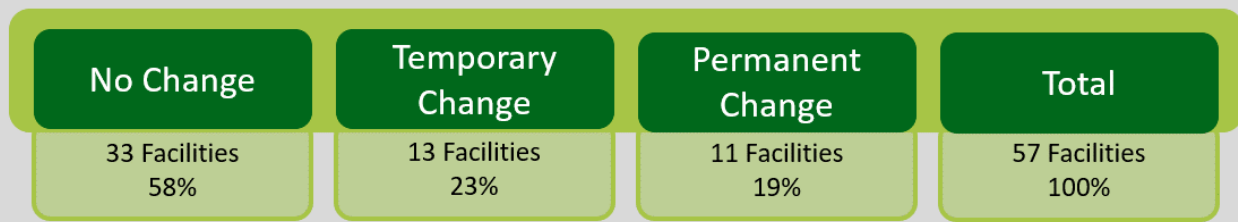| No Change	Temporary Change	Permanent Change	Total
33 Facilities	13 Facilities	11 Facilities	57 Facilities
58%	23%	19%	100%

FIGURE 4-1: SUMMARY OF COVID IMPACTS FOR EVT PROJECTS

A common reason for permanent changes was adjustments to facility hours of operation or production. For 9 out of the 11 sites, the permanent changes had a minimal impact on the summer or peak kW savings. For the other two projects, the permanent conditions found on site during metering were used as the baseline.

Thirteen sites had mandated temporary shutdowns or reduced hours of operation due to shelter-in-place policies that came into effect in March 2020. These sites generally reported lower hours of use. For the most part, the reduced hours of operation were outside the FCM peak periods and did not affect the verified savings analysis. For example, one grocery store reported an extra hour in the morning to accommodate elderly shoppers. Where AMI analysis was conducted, the period of the temporary change was removed from the analysis.

4.2 Smartlight Results

Results from the 63 respondents to the phone survey were weighted and applied to all C&I Smartlight sites. Table 4-6 provides the number of sites in the sample and winter and summer peak RRs. Stratum 1 contains sites with the smallest savings and Stratum 5 contains sites with the largest savings. The relative precision at the 80% confidence level is 12.4% for the winter, and 13.7% for the summer peak kW reduction.

TABLE 4-5: PEAK REALIZATION RATES BY PROJECT SIZE

Stratum Size	Total 2020 Sites	Sites in Sample	Winter kW RR	Summer kW RR
1	3,554	27	103%	60%
2	1,127	9	124%	60%
3	650	9	166%	99%
4	378	9	97%	65%
5	165	9	169%	97%
Total	5,874	63	131%	79%

The primary reason for the difference between the EVT program reported and PSD verified Smartlights savings is differences in applied load profiles. EVT characterized most indoor lighting projects, as having the TRM 2020 commercial #101 load profile. The PSD evaluation Team applied load profiles based on information collected during the phone survey regarding facility and space type where the efficient lighting was installed, operating hours, and ISRs. VLSA load profiles[10] were applied based on the type of facility where the efficient lighting was installed. The Northeast Residential Lighting Hours-of-Use Study[11] load profiles were applied to lighting measures installed in residential and MF apartments. There were also 8 sites with an ISR of 0% with six of these businesses being permanently closed. Further details from the Smartlight analysis are provided in Appendix C.

4.3 Residential Results

The next two sections describe the adjustments made to the residential prescriptive and efficient pool pumps.

4.3.1 Prescriptive Measures

The prescriptive residential measures in EVT's portfolio are characterized in the TRM. The PSD Evaluation Team compared the program reported savings to the TRM for these measures. Prescriptive measure savings were calculated as explained below.

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[10] *Vermont Load Shape Analysis. Final Report.* West Hill Energy & Computing. December 30, 2021.
[11] *Northeast Residential Lighting Hours-of-Use Study*; NMR Group, Inc. May 5, 2014

- o   Verified lighting CFs were based on the NEEP residential lighting study conducted in 2014. The RRs for residential lighting were 100% for the winter and 93% for the summer.

- o   The RR for prescriptive room air conditioners was based on the Residential Room Air Conditioner (RAC) CF study conducted in 2008.[12]

- o   CCHP CFs were based on the Vermont Residential CCHP Study.[13] There was no adjustment made to the residential prescriptive CCHPs as EVT correctly applied the load profiles from the TRM.

- o   The Vermont Thermal Study was used to calculate the RR for electric space heat measures.[14]

Option A was applied to all prescriptive measures using verifiable load shapes and assumptions based on the recent, statistically sound studies, as discussed above.

4.3.2 Efficient Pool Pumps AMI Analysis

In 2018, EVT completed efficient pool pump upgrades at 291 sites. These projects replaced existing swimming pool circulation pumps with new efficient pumps. The PSD Evaluation Team completed an AMI analysis to verify efficient pool pumps savings. Further details on the findings are provided in Appendix F. The RRs in the Appendix F efficient pool pumps study were applied to the PY2020 reported savings to calculate the evaluated savings.

4.4 Multifamily Results

The RRs for the MF sample were calculated in four steps:

1.   The program reported and evaluated savings for all three measures groups were combined for each project.

2.   The savings were aggregated by stratum, then weighted, and summed.

3.   RR was calculated from the weighted sum of program reported and evaluated savings.

4.   The RR was applied to the verified portion of the savings and the unverified savings were assumed to have an RR of 100%.

The final RR from the sample, after adjusting for the unverified measures, was applied to the total MF program reported savings. The results of this analysis are shown in Table 4-7 and the detailed analysis files were provided to EVT and the PSD.

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[12] "Coincidence Factor Study Residential Room Air Conditioners." Prepared for the Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group by RLW Analytics, Middletown, CT. June 23, 2008.

[13] "Evaluation of Cold Climate Heat Pumps in Vermont." Prepared for the Vermont PSD by the Cadmus Group Inc. November 3, 2017.

[14] "Impact Evaluation of Efficiency Vermont's Home Performance with ENERGYSTAR, Program Years 2014-2016", Prepared for Vermont PSD by West Hill Energy & Computing, September 10, 2018.
https://publicservice.vermont.gov/sites/PSD/files/documents/WHEC_EVTHPwES_IE_FinalDraftReport_100318_CLEAN.pdf.

TABLE 4-6: REALIZATION RATES FOR THE MF PROGRAMS

Period	EVT Program Reported Peak kW Reduction	Realization Rate	Evaluated Peak kW Reduction	Relative Precision
Winter kW Reduction	195.677	59%	116.211	12%
Summer kW Reduction	80.777	65%	52.351	11%

The RRs for the total program savings from the sample were applied to the savings for the population. Table 4-8 shows the unweighted RRs for the sample by measure group to provide additional information about the reasons for the RRs.

TABLE 4-7: REALIZATION RATE FOR THE SAMPLE BY MEASURE GROUP

Size Stratum	Program Reported kWh Savings	RR	Program Reported Winter Peak kW	RR	Program Reported Summer Peak kW	RR
Lighting	424,731	59%	71.952	55%	37.363	59%
Other Prescriptive	64,124	106%	8.777	100%	7.248	105%
Custom	269,719	50%	60.235	41%	9.067	8%

The RRs for the other prescriptive savings are 100% or higher indicating that the TRM values are being correctly applied. The lighting savings were overstated due to the incorrect application of the Residential Building Energy Standards (RBES)[15] baseline. The RRs for the custom measures are largely due to two of the four projects. One project was a NC project and the AMI data indicated that the building was performing worse than the baseline model as estimated by EVT, substantially affecting both the winter and summer peak savings. The second project was a retrofit and the pre/post analysis showed substantially lower savings than expected.

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[15] Vermont Residential Building Energy Code. Vermont Public Service Department, Planning & Energy Resources Division. Effective March 1, 2015.

5   Compliance with ISO-NE Standards

This section covers compliance of the verification results with ISO-NE standards. For residential prescriptive measures, the assumptions are supported by recent, statistically sound studies. For custom C&I projects, an individual, FCM-compliant M&V plan was developed for each project. Most of the ISO requirements are directly relevant to the C&I custom sample and are discussed in that context. ISO requirements are listed in reference to the section in the M-MVDR.

5.1   Section 6, Establishing Baseline Conditions

As specified in the manual, the baseline conditions for retrofit projects are the pre-existing conditions. If the pre-existing conditions could not be determined, then the applicable state code, federal product efficiency standard, or standard practice (if more stringent than the state or federal requirement) was used. For MOP projects, the baseline is the applicable state code, federal product efficiency standard, or standard practice (if more stringent than the state or federal requirement).

These principles were consistently applied to the custom C&I projects and documented in the individual project reports. In a few cases, there was no clear code or standard. In these situations, the Department's Evaluation Team researched the standard practice and developed the baseline using the best available information.

The same principles were applied in developing the deemed savings values and standard savings estimation algorithms that have been incorporated in the Vermont TRM. The TRM was compiled and is regularly updated based on applicable state code, federal product efficiency standards, or standard practice through the work of the Technical Advisory Group (TAG), which includes representatives of the Department, EVT, and industry experts. Use of the TRM for establishing baseline information for prescriptive measures thus represents one means of meeting the requirements outlined in Section 6.

5.2   Section 7, Statistical Significance

For engineering-based, direct measurement, the ISO manual requires strategies to control for bias, such as the accuracy and calibration of measurement tools, sensor placement bias, and sample selection bias or non-random selection of equipment and/or circuits to monitor. The site-specific M&V plans described the relevant issues for each project and discussed the methods used to mitigate bias. If the site-specific M&V approach required metering and there were too many circuits or measures to meter all, random sampling was conducted. These issues are described in more detail in the site-specific project reports, which are compiled in Appendix B.

In Section 7.2, the manual requires the overall portfolio meet the 80/10 confidence/precision standard. As discussed above, the verification of EVT's portfolio exceeds that standard, with a relative precision of 5.4% for winter and 5.7% for summer peak reduction.

Section 7.2 also specifies the need to minimize bias. Bias relating to the three components of EVT's portfolio is explored briefly below.

o For C&I custom sites, stratified ratio estimation was used to identify the sample and random sampling was conducted for the small and medium projects. Statistical methods meeting the ISO guidelines were applied and the sample sites were selected to reflect the population as a whole.

o In the analysis of the C&I custom measures, the PSD Evaluation Team avoided bias from the Covid-19 pandemic lockdown by eliminating the post-period months affected by changes in operation due to the lockdown. Businesses that closed were eliminated from the sample.

o The estimated savings for prescriptive measures are unlikely to be biased since the deemed savings are based on recent market studies.

The VLSA study was conducted to reduce uncertainty in the savings estimates for lighting measures in EVT's portfolio. This study was the source of the lighting CFs as it included Vermont facilities metered during prior FCM years and covered a broad range of applications. The study provides either Vermont-specific CFs or support for continuing to use the previous NEEP lighting study[16] CFs and allows continued use of standardized CFs in lieu of metering. Thus, the application of the VLSA study would not be expected to introduce a bias. The VLSA study is attached in Appendix D.

5.3 Section 10, Measurement Equipment Specifications

The PSD Evaluation Team verified that its metering equipment meets FCM M-MVDR standards.

5.4 Section 5, Acceptable Measures and Verification Methodologies

This section describes the specific allowable methods, Options A through D. For the C&I custom projects, Options A through D were selected on a site-by-site basis. All sites were evaluated using one of these options.

Option A was applied to prescriptive measures using verifiable load shapes and assumptions based on recent, statistically sound studies, as discussed above. The VLSA and NEEP study for C&I lighting, the residential room air conditioner (RAC) factor study for residential air conditioning, the NEEP residential lighting study for residential lighting, and the previous impact evaluation of CCHP installations in Vermont cover the vast majority of the prescriptive savings. For swimming pool circulator pumps, the FCM-compliant AMI analysis conducted for the PY2018 impact evaluation was applied.

The other measures used engineering estimates, as described previously. The kW reduction was estimated by using engineering estimates account for less than 6% of the total portfolio and thus the greater uncertainty associated with the load profiles was considered to be acceptable.

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[16] The stipulated profiles include grocery store, hospital, office, restaurant, retail, and warehouse indoor lighting. *C&I Lighting Load Shape Project FINAL Report.* Prepared for the Northeast Energy Efficiency Partnerships' Regional Evaluation, Measurement and Verification Forum by KEMA, Middletown, CT. July 19, 2011.

6   Conclusions

The PSD Evaluation Team completed its independent verification of EVT peak demand reduction. EVT's M&V plan, as submitted to ISO-NE, was the foundation for the sampling plan and verification activities conducted by the Department. The RRs were estimated from EVT's activity in PY2020. The M&V plan was followed and the results of the evaluation are consistent with the FCM standards, as specifically discussed in this document.

<table>
<tr><td>7</td><td>References</td></tr>
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